ASTRONOMY, GEOMETRY AND STATISTICS

Friday, 14th May, 3.00-4.30PM

Lecture Room C, JCMB

A continuing series of talks to foster interaction between the astronomy, physics and mathematics departments.

3.00PM Duncan Forgan http://www.roe.ac.uk/ifa/people/dhf.html

Using Monte Carlo Realisation Techniques to Model SETI

Since its inception, the Search for Extraterrestrial Intelligence (SETI) has been strongly influenced by the Drake Equation, which attempts to quantify how many communicating civilisations exist in the Milky Way. While an elegant phrasing of the problem, the Drake Equation's simplicity limits its ability to incorporate statistical data (such as the data currently being garnered on extrasolar planets).
I will outline how Monte Carlo Methods can be used to create "mock galaxies", which are imbued with the same statistical properties as the Milky Way, and how these deliver a much richer dataset concerning the growth and development of intelligent civilisations. While the Drake Equation can only deliver a single number, the mock galaxies technique can deliver a plethora of spatio-temporal data about the civilisations it produces, and identify the likelihood of contact between them. We may still be saddled with the traditional uncertainties surrounding life and its properties, but the mock galaxies can be used as a backdrop to play out different hypotheses of life and intelligence.

3.30PM Alan Heavens http://www.roe.ac.uk/ifa/people/afh.html

Hunting for inflation

Abstract: In the standard cosmological model, structures form from the unstable gravitational growth of quantum perturbations thought to be generated during inflation - a period of rapid expansion and acceleration of the Universe occurring roughly 10^{-35} seconds after the Big Bang. Can this extraordinary scenario be verified observationally? There are a couple of ways, one of which is investigated here. The quantum fluctuations should give rise to a perturbation field which is almost, but not quite, a Gaussian Random Field. Such fields have

statistical properties which are determined entirely by the two-point function (either the two-point correlation function, or equivalently the power spectrum). All models, however, predict small departures from a Gaussian Field, and these can in principle be detected by statistical analysis of light (the Cosmic Microwave Background Radiation) or matter. Detection of non-gaussianity is a major scientific goal for the Planck satellite CMB mission, currently observing, as it has the potential for ruling out many models of the early Universe. Most studies focus on the 3-point function - generally studied in harmonic space, where it is called the bispectrum. This is zero for a Gaussian Random Field, but not quite zero for inflation models. The talk will outline how this is currently done in an optimal way, and highlight an unsolved problem which puzzles the speaker.

Reviews tend to be large and cover a lot of ground:
http://arxiv.org/abs/astro-ph/0406398
http://arxiv.org/abs/1003.6097
http://arxiv.org/abs/1001.3957 (118 pages...)

4.00 Tom Kitching http://www.roe.ac.uk/ifa/people/tdk.html

The transformation of gravitational lensing: illuminating dark matter and dark energy.

I will introduce gravitational lensing - where light rays following geodesics in spacetime around massive objects can result in image distortion for every galaxy observed. I will explain how this information (which can be represented by a local conformal mapping of the source image plane) can be used to constrain cosmological parameters. I will then discuss various systematic effects in cosmology for which the underlying functional behaviour is unknown and introduce a variety of non-parameteric approaches that have been proposed to account for the impact of these on cosmological parameter estimation

Richard Massey http://www.roe.ac.uk/ifa/people/rm.html
Andrew Ranicki http://www.maths.ed.ac.uk/~aar